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Alfalfa Leafcutting Bee Newsletter: Volume II, No. 1

TITLE: Concepts of Pest Control and the History and Life Cycle of Chalkbrood

A. Concepts of Pest Control

There are certain principles that should be considered in a balanced approach to pest control of alfalfa seed and leafcutting bee production or any agricultural crop:

1. Potentially harmful species will be present at tolerable levels of abundance.
    a. Pest populations are to be kept below economically important levels; eradication is not the goal.
2. The environment (ecosystem) is the management unit.
    a. Climate, weather, soil type, wild pollinators, natural beneficial insect populations, the neighbors' management practices, weeds, etc., all have a role to play.
3. The use of natural beneficial insects is maximized.
    a. An understanding of how naturally occurring beneficial organisms (diseases and predators of plant pests, wild pollinators) work in the system is necessary so that optimal use can be made of their impact on target pest populations and seed production.
4. Any control procedure taken may result in unexpected or undesirable consequences.
    a. Examples are resistance to pesticides, mite and secondary pest outbreaks, the decline of beneficial insect populations.

5. Pesticides should be used only when necessary and one should realize which types are least toxic to beneficial organisms such as leafcutting bees (Bottrell, 1979).

Many times it seems control programs, instead of using the above 5 principles, are more inclined to use the following 3:

1. There is no understanding or concern for the boundaries of the field crop being managed. Target pests (spores, insects) are dealt with as if they are stationary and cannot move. Individual fields are treated as if independent of other fields, wild plant types and weeds.
2. Mortality of pests from beneficial organisms (viruses, parasites, predators) is poorly understood or ignored.
3. Monitoring or sampling (weekly sweeping) is not a part of field activities. Sampling plans are often inadequate and do not allow estimation of pest population levels with precision or accuracy (Barfield and O'Neil, 1984).

Since the mid 1970's, there has been progress made toward designing strategies and returning to pre-1940's concerns with balancing attacks against insect pests to avoid the undesirable consequences of approaches with total reliance on insecticides. To date, programs designed to suppress insect pest populations (by other means than insecticides) have been developed to a limited extent. Field scouts have solved some problems by providing information useful in determining insecticide applications. Problems continue to develop since a chemical or tactic may work in some locations or years and not in others. This may reflect a lack of understanding of basic biology and life cycles of target pests in certain areas of the country (violation of principle #5). The primary objective of agricultural pest control should be the maintenance of pests below economically important levels. Thus, rather than involve single insect types, this type of management includes complexes of pest and beneficial organisms.

However, the best directed management program possible and the best personnel available are useful only to the growers that utilize them. It is often said that if it is possible to demonstrate cost savings, then growers will adopt these programs, but this is generally not the case. Reports of chemical applications "just in case" are common (Violation of principle #1), due, in part, to a lack of confidence, in monitoring systems and the threshold

concept. Eventually we will be confronted with a critical question. How do we effectively implement environmentally and ecologically sound pest control programs within a free enterprise farm system? Education, grower organizations and the exchange of information will be critical factors (Barfield and stimac, 1980).

B. Chalkbrood: History and Life Cycle

As early as 1967, G. A. Hobbs reported a fungus parasitizing leafcutting bees in Canada. Unfortunately, he did not identify the fungus.

Thomas and Poinar (1973) identified a fungal disease of leafcutting bees which they had received from Dr. R. W. Thorpe of the University of California at Davis, but did not call it chalkbrood.

Skou (1972) identified *Ascosphaera proliperda* as the disease causing organism of a chalkbrood-like disease in a type of leafcutting bee (*Megachile centuncularis*) in Copenhagen, Denmark and stated that the disease had been present in greenhouse populations of the bee since 1967.

In a letter to N. D. Waters at the University of Idaho (December 31st, 1974), R. W. Thorpe stated that he first encountered chalkbrood diseased larvae of alfalfa leafcutting bees (*Megachile Rotundata*) in California as early as 1968. Thorp, in an unpublished report to the California Alfalfa Seed Production Research Board in 1976, reported mortality rates as high as 47% in leafcutting bees from Nevada.

In 1976, J. D. Eves, in an unpublished report entitled "Larval Mortality of the Alfalfa Leafcutting Bee", reported that mortality due to chalkbrood disease was averaging 9% in Washington, with a high of 20%, and was averaging 38% in Nevada.

From chalkbrood diseased alfalfa leafcutting bee larvae of Nevada, Skou (1975) indentified a new fungus species and proposed the name *Ascosphaera aggregata*, otherwise known as chalkbrood disease of alfalfa leafcutting bees.

N. D. Waters reported in his 1978 report "Chalk Brood Status Report" (Unpublished, University of Idaho), on the rapid rise of chalkbrood disease of leafcutting bees in Idaho. Prior to 1973, chalkbrood disease was present in Idaho at an average rate of about 0.1 percent, at which time it jumped to 1 percent. By 1975, chalkbrood disease had increased to 4 percent. One year later, it was up to 10 percent and by 1977 it had risen to 40 percent. In only 5 years, the incidence of chalkbrood disease had risen 400 fold in Idaho.

By the end of 1977, chalkbrood disease in leafcutting bees was occurring at a rate of 20 percent in Washington, 40 percent in Oregon and 50 percent in Nevada.

Due to uncontrolled transfer of alfalfa leafcutting bees from Idaho to Utah, chalkbrood disease has more recently become very prevalent in Utah, appearing in epidemic proportions in the delta area of Utah.

Chalkbrood disease has also become a problem in South America, as well as North America, with the disease infecting and killing leafcutting bees at rates of 65% in 1977 (Stephen & Undurraga, 1978). A shipment of bees 3 years earlier from the Shellbrook area of Canada to Argentina, was implicated as the original disease source.

In 1978 a multistate program was established to combat chalkbrood disease in the western United States. Due to disease control measures established by this program, the rapid increase of the disease has stabilized with Washington averaging 25 percent chalkbrood disease (Johansen, 1980) and Nevada averaging 30% chalkbrood disease (Arnett, 1980).

Chalkbrood spores are placed in the pollen-nectar mass of the leafcutting bee cell by the female. These spores are then eaten by the newly hatched bee larva during its first feedings. Within hours, the spores germinate in the gut. They form germ tubes, which grow rapidly, and within 12 to 24 hours penetrate the gut wall to enter the body cavity of the larva. Enzymes and waste products secreted by the fungus (mycleium) become concentrated as the disease progresses and the digestive system of the larva becomes overloaded. Progressively, over a 5-day period, the larva shows symptoms that include moderate swelling and a uniform discoloration from healthy white to offwhite or light brown. Approximately 8 days after penetration of the gut, the fungal cells in the body cavity are so dense that they begin to lodge and attack other tissues directly. Generally, between the 8th and 14th day, the bee larva dies. To make a longer story shorter, the cells in the area of the larval integument (outer skin) then initiate a sexual reproductive cycle which produces relatively large fungal cells massed in spore balls encased in spore bearing cysts. The walls of these cysts turn grey-brown just beneath the transparent larval skin to give the classic chalkbrood appearance to the cadaver. Some spores have been known to remain viable after 3 years, but these may represent only 1% or less of those produced on a single larval

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cadaver. However, this 1% may represent thousands of spores per nesting hole, due to the large numbers produced per cadaver (Kish and Stephen, 1983).

The question has been asked if acarine mites of honeybees are cross infective with leafcutting bees. The answer is no. The mite is a parasite of the respiratory or trachael system of the honey bee and is not compatible with the system of the smaller alfalfa leafcutting bee.

The history portion of this newsletter relating to chalkbrood was taken from the Masters thesis of W. R. McManus of the University of Utah at Logan (1982).

In our next newsletter we will address the biology and control of grasshoppers as they relate to alfalfa seed and pollinators.

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